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COMPILATION OF ABSTRACTS

PLATFORM PRESENTATIONS

Session 1: Contaminated Sediments

AN OVERVIEW OF THE CENTER FOR CONTAMINATED SEDIMENTS RESEARCH AT THE UNIVERSITY OF NEW HAMPSHIRE

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The Center for Contaminated Sediments Research (CCSR) has been housed at the University of New Hampshire since 2001. During this time the center has focused on a wide range of contaminated sediment topics including investigating beneficial use of contaminated dredged materials, developing and evaluating applications of in-situ reactive caps, developing passive in-situ monitoring devices, and evaluating dechlorination of PCBs, Dioxins and PCNs with palladized magnesium. These projects have afforded us the opportunity to work with a wide range of collaborators (DoD, NavFac, AECOM, CH2M-Hill, CDM-Smith, Arcadis, CETCO, AquaBlok, etc.) from bench scale laboratory studies to pilot scale field trials. Current work is looking at PFAS contamination in sediment systems. This presentation will provide an overview of the center's facilities as well as present select research that the center has conducted.

UPDATES IN SEDIMENT CORRECTIVE ACTION FROM THE ASTM TASK FORCE

Tamara Sorell (tsorell@BrwnCald.com), Brown & Caldwell, Nashua, NH

The ASTM Task Force is in the process of developing three separate standards for sediment corrective action: 1) Risk and Corrective Action Objectives, 2) Monitoring, and 3) Analytical. The draft Analytical standard is complete and is in the final process of balloting. The other Standards are under preparation and will be completed and submitted for balloting later this year. This presentation will describe the overall objectives of the Task Force and summarize the Risk/CAO and Monitoring standards, including the intended use, technical content, and proposed methodological appendices. The Analytical standard will be described in a companion presentation. This presentation is intended to foster a discussion with the audience consistent with the Stakeholder engagement aspect of the Standard development process.

AN OVERVIEW OF ASTM WK54455, STANDARD GUIDE FOR THE SELECTION AND APPLICATION OF ANALYTICAL METHODS AND PROCEDURES USED DURING SEDIMENT CORRECTIVE ACTION

James Occhialini (jocchialini@alphalab.com), Alpha Analytical, Mansfield, MA

This presentation will provide an overview of the ASTM Contaminated Sediments Analytical Guide. The goal of the guide is to highlight best practices to improve project outcomes, increase transparency of complex technical concepts, and compile a compendium of sediment analytical methods, test procedures, and best practices. The guide is composed of six sections, which are Physical Properties, Chemistry Analytical Methods, Passive Sampling, Biological Testing, Forensic Analytical Methods, and Method Development. A summary of the content and the status of the document will be provided.

Session 2: Risk Assessment/Toxicology/Chemistry

MANUFACTURED GAS PLANT WASTE: CHALLENGES IN RISK ASSESSMENT

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Historic Manufactured Gas Plant wastes, especially coal tars, present unusual challenges to traditional quantitative risk characterization. Coal tar wastes released to local waters often extend far downstream, causing habitat degradation through smothering and ecological toxicity. The traditional approach of assessing risks to human health and the environment from individual polycyclic aromatic hydrocarbons and other contaminants does not fully describe the risks from complex coal tar mixtures and extensive waste deposits. A combination of traditional quantitative and qualitative risk assessment approaches can provide a more representative characterization of the risks at these sites.

A LABORATORY APPROACH TO TESTING VITELLOGENIN (VTG) AS A PART OF A COMPREHENSIVE ENDOCRINE DISRUPTOR SCREENING PROGRAM: A VTG ELISA THAT PRESERVES THE FISH

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Vitellogenin (VTG) in fish is an estrogen-induced yolk precursor protein mainly synthesized in the liver prior to deposition in the maturing oocytes where it is split in the yolk proteins lipovitellin 1, lipovitellin 2 and phosvitin. These proteins provide nourishment for developing embryos. Due to its estrogen-dependent synthesis, vitellogenin is considered as a hallmark “female protein”. Since male and juvenile fish do not produce much estrogen, their vitellogenin levels are quite low and non-physiological induction of vitellogenin in these fish is thought to indicate estrogen mediated endocrine disruption. Therefore, vitellogenin determination is one of the core endpoints in screening and testing for endocrine disrupting chemicals standardized in the OECD Guidelines for the testing of chemicals for estrogenic activity.

Historically, vitellogenin measurement has been limited to blood or whole-body homogenate (WBH) samples - both of which are sample types that require invasive and destructive treatment of fish. Recent studies, however, have shown that vitellogenin can also be detected in the epidermal mucus of fish though the VTG concentration there can be significantly lower compared to that in blood or WBH. Thus, suitable methods for mucus collection and vitellogenin determination in mucus are required. The TECO Vitellogenin System is unique in that it includes a validated mucus collection set for gentle and effective mucus sampling adapted to a highly sensitive laboratory ELISA test. The assay offers the following advantages: a simple, standardized sampling technique; a non-invasive and non-destructive sampling procedure; a defined sample matrix free of protease contamination from non-target tissues or lymphatic fluid; and an optimal procedure for obtaining vitellogenin samples during field testing. Beyond vitellogenin testing, DiaPharma also supplies a Cortisol ELISA that has been validated for use with epidermal fish mucus. This assay's ability to measure free cortisol in mucus may be a beneficial new approach in determining stress levels of fish. This presentation will describe the background associated with the development of this assay, how it can be used as a part of a comprehensive endocrine disruptor screening program and future directions utilizing fish mucus samples to measure related endpoint proteins.

AMBIENT IONIZATION FOR THE RAPID ANALYSIS OF ENVIRONMENT CONTAMINANTS

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Direct analysis of target analyte by mass spectrometry becomes challenging at ppt levels, which are the typical levels of environmental toxins and emerging contaminants. Currently, the conventional analysis of trace level environmental contaminants relies on solid phase extraction (SPE) and liquid chromatography tandem mass spectrometry (LC-MS/MS). Typically, hundreds mL samples are concentrated to 1 mL methanol solution, which would be above the detection limit. The SPE procedure takes more than 25 minutes, not to mention other tedious LC procedures. An

ambient mass spectrometry method with preconcentration capability is much desired for the rapid (<1 min) analysis of environmental samples.

Low concentration sample solutions were loaded into pulled glass emitters. The volume of sample solution was reduced several orders of magnitude by controlled evaporation. After desired concentration, the sample solution was directly ionized from the emitter by relay electrospray ionization, in which primary ions from a piezoelectric discharge ion source were deposited onto the emitter to trigger the ionization of analyte solution. The generated analyte ions were then trapped, fragmented and analyzed by a linear ion trap mass spectrometer. Trapping and fragmentation parameters were optimized to generate extensive backbone fragments for the target analyte. The absolute intensities and relative ratios of the fragments were used for quantitation and qualification purposes. Various evaporation control strategies were evaluated.

The pulled glass capillary emitter, with a cylindrical body and a conical head region, is advantageous for monitoring this preconcentration effect for solutions loaded in it. In the cylindrical section, the volume is linearly related to length. When in the conical head region, the volume is a cubic function of the length— meaning a 10-fold decrease in length corresponds to 1000-fold increase in concentration. In our experiment, 10 µl methanol solutions were readily evaporated to 300 nL concentrated solution.

Relay ESI successfully triggered ionization of nanoliter volume sample, resulting in repeatable pulse ion signals. When Perfluorooctanesulfonic acid (PFOS) was the target analyte, the limit of detection (LOD) is 500 ppt without preconcentration. For sample solutions below this LOD, only with the *in situ* evaporative preconcentration the could the characteristic fragmentation pattern be detected. Controlled evaporation is an efficient and effective approach to the rapid analysis of ultra-low-level target analytes.

Session 3: Emerging Contaminants I

INTRODUCTION TO PFAS.

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This presentation will provide background on per- and polyfluoroalkyl substances (PFAS). PFAS are a large class of man-made chemicals that are an emerging worldwide priority in environmental and human health because some are environmentally persistent, bioaccumulative, and pose human health risks. Two of the more persistent and bioaccumulative PFAS, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), are no longer manufactured or used by major chemical companies in the U.S. and Canada because of voluntary industrial phaseouts. In 2016, the U.S. Environmental Protection Agency issued drinking water health advisories and Health Canada issued drinking water screening values for certain PFAS. Since then, many states and provinces have issued drinking water, groundwater, and/or surface water advisories and regulatory limits. This introduction will provide a brief overview of the various sub-classes of PFAS, how they are used, and where they are found.

PFAS RELEASE, DISTRIBUTION AND EXPOSURE ROUTES – CASE STUDY NORTH BENNINGTON, VERMONT

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PFAS releases to the environment can result in multiple routes of exposure to the public. Due to the unique chemical properties of PFAS, traditional and non-traditional distribution and re-distribution methods can increase the number of potential exposure routes over time. The case study presented evaluates the North Bennington/Bennington Vermont PFAS Release site. Manufacturing of specialty fabrics over the course of several decades has resulted in wide spread PFAS impacts throughout the community. The presentation will discuss the current understanding of the initial PFAS releases and subsequent distribution in environmental media and resulting exposure to the public. Spatial impacts to water supplies, shallow soil, surface water and biosolids throughout the community will be presented. A discussion of current and anticipated long term release related exposure mitigation methods is also included.

PERFLUOROALKYL SUBSTANCES: RISK-BASED ASSUMPTIONS FOR NEW ENGLAND DRINKING WATER

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Perfluoroalkyl substances have been the focus of regulatory review since the United States Environmental Protection Agency's release of Drinking Water Health Advisories for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). The presentation will provide the basis for federal health-based advisories for PFOA and PFOS, and an understanding of general toxicological concerns associated with compounds under review in New England. Denise will present the exposure and toxicological bases for the Drinking Water Health Advisories for PFOA and PFOS, as well as alternative drinking water values developed by the State of Vermont. She will also include a discussion of those compounds selected by Connecticut and Massachusetts for further drinking water review, including PFOA, PFOS, perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and perfluoroheptanoic acid (PFHpA).

ESTIMATING SAFE LEVEL OF PFOA/PFOS IN HUMAN BLOOD USING CLINICAL MARGINS-OF-SAFETY

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Compared to other environmental contaminants (e.g. heavy metals, formaldehyde, PCBs, etc.), PFOA and PFOS are less potent to mammals. Epidemiological studies that have found a "link" between PFOA/PFOS and other diseases (ulcerative colitis, testicular cancer, elevated cholesterol, hypertension) are based on weak statistical associations. Despite this, the long half-life of PFOA/PFOS in humans has resulted in one of the lowest drinking water advisories ever issued by USEPA (70 ppt). This study estimates a "safe" level of PFOA/PFOS in human blood using conservative margins-of-safety identified for baseline levels of other ubiquitous environmental contaminants.

Using the NHANES (National Health and Nutrition Examination Survey) database, we identified "normal" background levels of environmental contaminants in human blood (heavy metals, BTEX, MTBE, PCBs, DDT). We then identified clinical "Reference Values" (i.e. the normal range in human blood) and "Critical Values" (i.e. the lowest blood concentration that necessitates a clinical intervention) for each contaminant. We then divided the Critical Value for each contaminant by the average (mean) concentration observed in human blood to obtain a margin-of-safety. Using the calculated ranges for the resulting margin-of-safety, we then estimated a "safe" level of PFOA/PFOS in human blood. This assumption of safety is based on the concept that the inherent potency of PFOA/PFOS would always be less (lower toxicity given the same concentration) than the any of contaminants that have routinely been monitored in humans in the current NHANES database.

For cyanide and heavy metals, the average (mean) values cited in the 2016 NHANES Report fell within the normal ranges cited for clinical Reference Values. The mean concentration of PFOA (~3 µg/L) was lower than a normal blood level for cyanide (~4 µg/L) and the mean concentration of PFOS (6.3 µg/L) was slightly lower than the normal blood level of lead (~11.2 µg/L). The clinical margin-of-safety values ranged from 3 – 23, with an average MOS of 14.5. In the US, the levels of PFOA/PFOS measured in human blood for a "high-exposure community" following exposure to contaminated groundwater would be about 10 times the level presented above. Based on our analysis, and knowing that heavy metals are clearly more potent than PFOA/PFOS in terms of either acute or chronic effects, we opine that the current levels of PFOA and PFOS in the bloodstream of the U.S. population would not present either a short-term nor a long-term risk.

Session 4: Emerging Contaminants II

POTENTIAL FOR PFAS CROSS-CONTAMINATION FROM SAMPLING EQUIPMENT AND ASSOCIATED PRODUCTS

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Special handling and care is always advised when collecting samples for PFAS analysis to avoid sample contamination. The potential presence of PFAS in common consumer products and in equipment typically used to collect environmental samples, coupled with the need for very low reporting limits heightens this concern. Can PFAS be transferred from common field and other commercial products during sampling? There are a lot of sampling recommendations in the literature but little actual data. In this study, the authors investigate what the potential for cross-contamination is from a number of commonly used products, with the emphasis on evaluating what the possible worst-case scenario for cross-contamination could be. PFTE, LDPE and HDPE tubing, pump bladders, and personal protective equipment are evaluated along with associated products such as aluminum foil and plastic storage bags. In the experimental design of this study, the products themselves are not analyzed directly as in an assay. Rather, a series of experiments are performed utilizing a leaching model to evaluate the potential for cross-contamination and false positive environmental sampling results. All data is presented along with experimental observations and recommendations.

THE EMERGING CONTAMINANT 3,3' DICHLOROBIPHENYL (PCB-11) IMPEDES AHR ACTIVATION AND CYP1A ACTIVITY TO MODIFY EMBRYOTOXICITY OF AHR LIGANDS IN THE ZEBRAFISH EMBRYO MODEL (*DANIO RERIO*)

Monika Roy, MSPH, (monikaroy@umass.edu), PhD Student, Environmental Health Sciences, School of Public Health & Health Sciences, University of Massachusetts, Amherst, Timme-Laragy Lab, N424 Morrill I

3,3'-Dichlorobiphenyl (PCB-11) is a non-legacy PCB congener widely detected in environmental samples, but its toxicity potential is poorly understood. We measured PCB-11 in environmental samples and assessed its embryotoxicity and interactions with the aryl hydrocarbon receptor (Ahr) pathway using zebrafish (*Danio rerio*). PCB-11 was measured in wild freshwater fish samples from a river in Massachusetts. Based on environmental concentrations, zebrafish embryos were exposed to 4.5 ng/L, 4.5 µg/L, or 4.5 mg/L PCB-11 from 24-96 hours post fertilization, when they were assessed for morphology and Cyp1a activity using the *in vivo* EROD bioassay. Ahr pathway interactions were probed by co-exposing zebrafish to the Ahr agonists PCB-126 and the model PAH beta-naphthoflavone (BNF). Zebrafish exposed to 4.5 mg/L PCB-11 were also collected at 96 hpf for qRT-PCR and histology. Environmental concentrations of PCB-11 ranged from 103.0-136.0 ng/kg in fish tissue. Exposure to PCB-11 alone did not induce deformities or EROD activity. In co-exposures, 4.5 mg/L PCB-11 prevented deformities caused by PCB-126 but exacerbated deformities in co-exposures with BNF. PCB-11 measured in this study is present at concentrations that are within the EPA human health screening value for fish consumption and are within regulatory emissions limits for industries. Higher concentrations that may be present elsewhere such as the 4.5 mg/L PCB-11 concentration tested in zebrafish, can act as both a partial agonist/antagonist of the Ahr pathway, and as an antagonist of Cyp1a activity to modify the toxicity of compounds that interact with the Ahr pathway.

TOXICOLOGICAL RESPONSE OF *CHIRONOMUS TENTANS* TO SIX PERFLUOROALKYL COMPOUNDS

Chris McCarthy (Chris.McCarthy@ch2m.com) (CH2M, Boston, MA); Mike Stanaway (CH2M Applied Sciences Laboratory, Corvallis, OR); Chris Salice (Towson University, Baltimore, MD); Justin Rewerts (Oregon State University) Kelly O'Neal (CH2M, Sacramento, CA); Demitria Wright (CH2M, Denver, CO)

A multi-faceted bioassay study was conducted on six different perfluoroalkyl substances (PFAS) with the intent of obtaining data to evaluate relative or proportional toxicity between the substances. The six substances were selected off of the EPA's third Unregulated Contaminant Monitoring Rule (UCMR3) list. Two of the substances, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), are well studied. The other four substances (Perfluorononanoic Acid [PFNA], Perfluorobutanesulfonic Acid [PFBS], Perfluorohexanesulfonic Acid [PFHxS], and Perfluoroheptanoic

Acid [PFHpA]) are commonly detected in groundwater around the US, but far less is known about their toxicological potential. 10-day acute range finding tests and 20-day chronic definitive renewal bioassays were run on all six compounds. Exposure doses were established above and below environmentally relevant concentrations. Measurement endpoints included: percent survival; growth. Results from the 10-day acute survival tests were used to inform dosing for the 20-day chronic growth tests. Dose response curve fitting was performed for each compound. Results are in concert with previous work showing PFOS to be the most toxic PFAS and additive toxicity with PFHxS. Additive toxicity with other PFAS appears less clear and needs further investigation. Results of this work will be considered in conjunction with other ongoing work testing the same compounds and mixtures to look for patterns of similarity among differing classes of organisms.

POSTER ABSTRACTS

CHARACTERIZING THE PFAS CONTAMINATION OF THE BARNES AQUIFER IN WESTFIELD, MA

Christopher W. Clark (cwclark@umass.edu), Kristen L. Mello, M.Sc., University of Massachusetts Amherst

In May 2013, the City of Westfield, MA received test results indicating the presence of per- and polyfluoroalkyl substances (PFAS) in four of its eight municipal water supply wells, which were tested as required by the Unregulated Contaminants Monitoring Rule 3 (UCMR3). These four wells all tap into the Barnes Aquifer, north of the Westfield River. The presence of these compounds has been attributed to fire fighting training that occurred at the Barnes Air National Guard Base from the 1950s to 1987, which utilized PFAS containing Aqueous Film Forming Foam (AFFF) since the early 1960s. The objective of this work is to characterize the PFAS contamination of the Barnes Aquifer in Westfield, MA using all the currently publicly available data. Analyses were conducted by certified testing facilities using the modified method EPA 537.1 or, previous to its modification, EPA 537 or a proprietary method. Samples taken from municipal and monitoring wells and during a Massachusetts Department of Environmental Protection (MassDEP) study of private wells, had results indicating total PFAS concentrations within the Barnes Aquifer ranging from <2 ng/L to 2100 ng/L(ppt). Samples taken from wells located nearest to the original firefighting training “burn pit” accounted for the majority of the highest PFAS concentrations detected overall, particularly the two most contaminated municipal wells, numbers 7 and 8, located less than a mile away. Human exposure to PFAS through drinking water warrants further risk assessment and biomonitoring of Westfield residents due to the associated adverse health effects.

DEVELOPMENT OF A PASSIVE LIGNIN POREWATER SAMPLER FOR METALS

Dr. Stephen Clough (sclough@haleyaldrich.com); Jay Peters (jpeters@haleyaldrich.com) (Haley & Aldrich, Inc, Bedford, NH); Jim Occhialini (jocchialini@alphalab.com) (Alpha Analytical Laboratory, Mansfield, MA)

The best available science has shown that porewater is the “best predictor of toxicity” (and therefore risk) as the bioavailable fraction of sediment resides in this medium. Most ecological risk assessments continue to use total (bulk) sediment concentrations to assess risk. Biologically based endpoints can be costly to perform and results are often difficult to interpret without additional toxicity identification evaluation(s). A review of porewater samplers for metals revealed a strong need for a rapid, reliable screening tool for the measurement of divalent metals in sediment porewater. Using information from early metal binding experiments, we have conducted successful pilot studies using lignin, a natural polymer that has been shown to effectively bind divalent metals. Dose-dependent studies showed that the modified (calcium substituted) lignin has a high capacity for the binding of copper, cadmium, lead and zinc and that the polymer would not become saturated under naturally occurring ranges of pH or at concentrations encountered in contaminated sediments.

Time-dependent studies show that the modified lignin will rapidly bind divalent metals and therefore deployment periods would be short (<24 hours). Experiments with varying concentrations of equimolar mixtures of these metals show that the relative binding strength follows the order Pb > Cu > Zn > Cd (strongest to weakest). Early binding experiments (using a polysulfone hardening agent) to form passive sampler “strips” of solidified lignin showed uptake of metals at low concentrations is strongly linear ($r = 0.99$). Experiments using this new sampler “in situ” also show that uptake is correlated with metal concentrations in porewater. These initial field studies show that a lignin-based porewater sampler has strong potential to rapidly screen sediments for metals in porewater. This would significantly reduce investigation costs while gaining information on the relative distribution (and bioaccessibility) of metals of metals in sediments.

AN INVESTIGATION OF WATER AND AEROSOLS AS PATHWAYS FOR CYANOBACTERIA TOXINS FROM LAKES TO CROPS

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Cyanobacteria are ubiquitous photosynthetic prokaryotes commonly found in both nutrient rich (eutrophic) freshwater systems and clear low-nutrient (oligotrophic) systems. Microcystin (MC), a potent liver toxin and tumor promoter, is the toxin most commonly produced by cyanobacteria, and has been found to accumulate in plant tissues. I am presenting the results of my Masters research on the accumulation of MC in radishes and lettuce plants due to exposure via irrigation water and aerosolized toxins from a lake with cyanobacteria. In August of 2016, radishes and lettuce were grown hydroponically under low tunnels on a dock on the shore of Lake Attitash in Amesbury, MA. Plants were exposed to MC at the roots by using lake water in the hydroponic reservoirs and at the leaves via aerosolized toxins from the lake surface. As controls, tap water was used in the hydroponic reservoirs and the low tunnels were sealed with HEPA filtration to remove aerosolized particles. Low levels of MC were measured from plants in all treatments, with no significant differences between treatments in lettuce plants ($p > 0.05$ ANOVA). A follow-up experiment was conducted in the summer of 2017 to determine if MC was passing through the HEPA filters, and if it was in the particulate or dissolved form. MC was found in liquid trap samples after first passing through the HEPA filter and a $0.2\mu\text{m}$ air filter, indicating that the toxin was in the dissolved form. This indicates that aerosolized dissolved toxins could be a major source of MC exposure to plants, humans, and wildlife near the shoreline of lakes with cyanobacteria populations. As cyanobacteria and their toxins become more and more prevalent, understanding routes of exposure to them is essential to reduce and prevent their negative impacts on humans and wildlife.

POLYSTYRENE MICROBEADS AS A VECTOR FOR GEMFIBROZIL CONTAMINATION IN THE BAY SCALLOP LARVAE (*ARGOPECTEN IRRADIANS*)

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Plastics are a major contaminant in our ocean, and both the micro (<5mm) and macro-sized particles are a hazard to marine life. One impact of microplastics is their ability to absorb other contaminants, providing a pathway for these contaminants into marine life. Gemfibrozil (GEM) is a fibrinolytic drug on the Environmental Protection Agency (EPA)'s list of contaminants of emerging concern. GEM has been detected locally in the waters near Nantucket Island, MA at concentrations of 4 ng/L and in European Rivers at concentrations up to 300 ng/L and has been shown to be toxic to Mediterranean mussels. Our objective was to determine if polystyrene microbeads (PSB) could be a vector for GEM and determine if GEM was toxic to bay scallop larvae (*Argopecten irradians*). Simultaneous experiments were run with GEM exposure and PSB that were treated with GEM at the same seven concentrations (.3, 1, 3, 10, 30, 100, 300 ng/L) as well as clean water and virgin PSB controls. The measurement endpoints were mortality, shell height, and the ratio of lipid to body mass. Acute mortality results show that PSB increased mortality when compared to controls, and GEM treated PSB had higher mortality than Virgin PSB. Significant difference in mortality occurs between treatment groups, and across concentrations. During an extended effects study, Mortality increased across concentrations and treatment groups after 7 days. Shell height increased over time but increased at a slower rate as exposed GEM concentration increased and also in the presence of PSB.

TOXICOLOGICAL RESPONSE OF *CHIRONOMUS TENTANS* TO SIX PERFLUOROALKYL COMPOUNDS

Chris McCarthy (Chris.McCarthy@ch2m.com) (CH2M, Boston, MA); Mike Stanaway (CH2M Applied Sciences Laboratory, Corvallis, OR); Chris Salice (Towson University, Baltimore, MD); Justin Rewerts (Oregon State University) Kelly O'Neal (CH2M, Sacramento, CA); Demitria Wright (CH2M, Denver, CO)

A multi-faceted bioassay study was conducted on six different perfluoroalkyl substances (PFAS) with the intent of obtaining data to evaluate relative or proportional toxicity between the substances. The six substances were selected off of the EPA's third Unregulated Contaminant Monitoring Rule (UCMR3) list. Two of the substances, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), are well studied. The other four substances (Perfluorononanoic Acid [PFNA], Perfluorobutanesulfonic Acid [PFBS], Perfluorohexanesulfonic Acid [PFHxS], and Perfluoroheptanoic

Acid [PFHpA]) are commonly detected in groundwater around the US, but far less is known about their toxicological potential. 10-day acute range finding tests and 20-day chronic definitive renewal bioassays were run on all six compounds. Exposure doses were established above and below environmentally relevant concentrations. Measurement endpoints included: percent survival; growth. Results from the 10-day acute survival tests were used to inform dosing for the 20-day chronic growth tests. Dose response curve fitting was performed for each compound. Results are in concert with previous work showing PFOS to be the most toxic PFAS and additive toxicity with PFHxS. Additive toxicity with other PFAS appears less clear and needs further investigation. Results of this work will be considered in conjunction with other ongoing work testing the same compounds and mixtures to look for patterns of similarity among differing classes of organisms.

DEVELOPMENT OF PASSIVE SAMPLER METHOD FOR MEASURING CONCENTRATION OF PER-AND POLYFLUOROALKYL SUBSTANCES (PFAS)

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Per-and polyfluoroalkyl substances (PFAS) are a class of mobile, and persistent anthropogenic chemicals that have been well documented in abiotic and biotic matrices across the globe. PFAS have been used since the 1950s as surfactants in industry; firefighting foams; alkaline cleaners; paints; and consumer products such as non-stick cookware, carpets, food packaging, shampoos due to their unique water and oil repellency, high surface activity, and thermostability. This broad application in combination with PFAS persistence in the environment and potential ecological and human health impacts has created a critical need to monitor their presence and concentration in the environment. Passive in-situ sampling is a technology that can provide important insights for monitoring PFAS in this field. Contrary to conventional sampling techniques, passive samplers are generally deployed in the environment for extended periods of time and measure only the mobile, free phase of the designated target compound(s). Historically, this has led to a better assessment of the bioavailable fraction of the compounds present and provided a temporally averaged concentration that is more biologically relevant. However, there is a sampling gap of PFAS in sediment porewater due to different properties in sediment, an important matrix at the base of the aquatic food chain. This work provides a baseline for understanding research needs to develop sampling method for measuring PFAS concentration in sediment. In this regard, the effect of flow rate, and PFAS availability in sediment porewater on PFAS sorption rate in sampler is investigated. Also, the effect of sorbent properties on sorbent-water sorption coefficient (k_{sw}) and the accumulation of PFAS (K_{mw}) in membrane is described.

CHARACTERIZING CYANOBACTERIA AEROSOLS FROM NEW ENGLAND LAKES: EFFECT OF TROPHIC STATUS AND DIEL DIFFERENCES

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Cyanobacteria have been detected in aerosols, suggesting an ecosystem transfer from lakes to atmosphere that could be an important route of exposure to these cells and the toxins they produce. Microcystins (MCs) are liver toxins that cause liver failure and tumors. Beta methylamino-L-alanine (BMAA) is a neurotoxin suspected to be an environmental trigger for neurodegenerative diseases. The purpose of this study was to 1) characterize cyanobacteria aerosols generated from a range of lakes with varying trophic status 2) determine how diel differences affect aerosolization rates from these lakes. Aerosols were collected directly above the lakes for a nine-hour period during the day, and another nine-hour period following sunset. Eight lakes were sampled and ranged from bloom conditions to oligotrophic systems. MC and BMAA levels were measured on aerosol filters using the ELISA method, and the abundance of cells on aerosol filters were enumerated using epifluorescence microscopy. Preliminary results show that aerosolization rates may be more dependent on community composition than overall trophic status. In addition, this community composition may be responsible for the differences seen between day and night aerosolization rates. Understanding the factors that influence cyanobacteria aerosolization will lead to better control of exposure to cyanotoxins in the future.

EXPOSURE TO OXYBENZONE DURING THE PERINATAL PERIOD DISRUPTS DEVELOPMENT OF THE MALE AND FEMALE MOUSE MAMMARY GLAND

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The mammary gland is a structurally dynamic organ, with distinct growth and differentiation observed during embryonic development, puberty, pregnancy, lactation, and involution. It has been hypothesized that each stage is uniquely sensitive to environmental insults. Development of the mammary gland occurs under the influence of sex hormones, prolactin and growth hormones, and has been shown to be sensitive to compounds mimicking those hormones as well as chemicals that interfere with their receptors. One compound that has recently received attention is oxybenzone (benzophenone 3, BP-3), a chemical absorbing UV radiation. BP-3 is a suspect endocrine disrupting chemical with antiestrogenic and antiandrogenic properties. In our study, we exposed Balb/c mice to three different, low doses of BP-3 in utero and during the perinatal period and quantified growth parameters in the mammary glands of male and female pups at three stages of life: prior to the onset of puberty, at the height of puberty, and in adulthood.

We found that male mice exposed to low doses of BP-3 during perinatal development showed significant reduction in the area of mammary gland epithelium and the number of branching points, and exhibited lower potential for ductal extension and growth at the pre-pubertal age. In contrast, female mice displayed increased ductal extension at puberty. Our results are consistent with a strong potential of BP-3 altering normal mammary gland growth and development in both sexes of mice. Future studies will evaluate other endpoints including expression of hormone receptors, markers of proliferation, and hormone-dependent gene expression.

Microplastics Abundance in the Charles River Lower Basin

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Plastic is the number one source of marine debris and highest concentrations of plastics are found in coastal waters. The plastic can be input into the coastal waters through rivers, run-off from the land, litter, human interaction with the water, and from wind. While the effect of microplastics on marine ecosystems are well-documented, little is known about the release and retention of microplastics in rivers. It has been estimated that 300 million microfibers could enter the ocean daily from the Hudson River. The objective of our study was to do a preliminary survey on the amount and size of microplastics present in the lower portion of the Charles River in Massachusetts. The Charles River flows through the heart of Boston and is an important source of freshwater to Boston Harbor. Throughout the summer of 2017, surface grab-water samples were collected under four bridges in the Lower Basin (North Beacon St, Larz Anderson, BU, Longfellow) and concentrations of microplastics were found ranging from 46 – 484 particles per liter. Data also reflects a trend of higher abundance upstream at North Beacon Street and decreasing at each subsequent downstream location towards the Longfellow Bridge. Further analysis will measure the distribution of microplastic sizes to determine if it changes with location. The size and the abundance of the microplastics will also be compared with immediate land use (e.g. boating docks, turf fields, streams). Relatively little is known about the abundance and impacts of microplastics in rivers and few estimates on the flux from rivers to the ocean have been estimated. We plan to continue this study and examine the amount and type of plastic present and estimate the flux of microplastics from the Charles River into Boston Harbor.

Exposure to antimicrobials found in the environment perturbs gut microbiota in mouse *in vivo* and in human fecal bacteria *ex vivo*

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Antimicrobials, specifically triclosan (TCS), triclocarban (TCC), benzalkonium chloride (BAC), benzethonium chloride (BET), and chloroxylenol (PCMX), are antimicrobials used in personal care, medical, and industrial products, such as soap, toothpaste, kitchen cutting boards, and toys. A better understanding of their effects on human health could impact regulatory policies and public health. The gut microbiome plays a critical role in human health, and a disturbed microbiome is associated with the pathology of many human diseases such as inflammatory bowel disease (IBD) and colorectal cancer. Here, using 16s ribosomal RNA (rRNA) sequencing, we found that oral administration of antimicrobials, at levels found in the environment and in humans, changed the structure and composition of gut microbiota at both phylum and genus levels in C57BL/6 adult mice *in vivo*. Exposure to these antimicrobials increased bacteria that have been shown to be correlated with IBD, while they decreased bacteria that are known to be beneficial to the gut. In addition, we found that TCS, TCC, and BET, were found to impact the diversity of the gut microbiome in these mice. We also studied the effects of antimicrobial exposure on the human gut microbiome and found that treatment with TCS altered the composition of gut microbiota in cultured human fecal bacteria *ex vivo*. Together, these results demonstrate that exposure to antimicrobials could modulate the gut microbiota. Further studies are needed to better characterize the effects of antimicrobial exposure on the gut microbiome and associated diseases.